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Monetary Transmission: Are Emerging Market and Low Income Countries Different?

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Monetary Transmission: Are Emerging Market and Low Income Countries Different?[1]

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Abstract

We use two alternative representations of the yield curve to test the functioning of the interest rate transmission mechanism along the yield curve based on government paper in a sample of emerging market and low-income countries. We find a robust link from short-term policy and interbank rates to longer-term bond yields. Two policy implications emerge. First, the presence of well-developed secondary financial markets does not seem to affect transmission of short term rates along the yield curve. Second, the strength of the transmission mechanism seems to be affected by the choice of the monetary regime: countries with a credible inflation targeting regime seem to have "better behaved" yield curves than those with other monetary regimes.

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1 Introduction

We explore a part of the transmission mechanism in a sample of 16 countries that includes advanced, emerging market, and low-income countries, generally finding "well-behaved" yield curves and a functioning monetary transmission mechanism. By "well-behaved" we mean that policy or short-term interbank interest rates are transmitted seamlessly to market-determined, longer-term bond rates in all countries, with no arbitrage. The nominal interest rate part of the transmission mechanism appears to be functional and largely identical in all sample countries, including low-income ones, suggesting that the role traditionally ascribed to secondary markets can be fulfilled by primary markets.

After the financial crises of the 1990s and 2000s, many emerging market and low-income country central banks began reviewing their monetary frameworks to make policy more forward-looking, in order to promote macroeconomic stability, growth, and financial development. At the same time, these central banks felt uncertain about how monetary policy would transmit to longer term rates, and eventually, to output and prices. The task of identifying the transmission mechanism has been challenging in the environment of short, noisy time series plagued by policy-driven breaks and supply shocks. In generally, there is little agreement on the efficiency of monetary transmission in low-income and emerging market countries.[1]

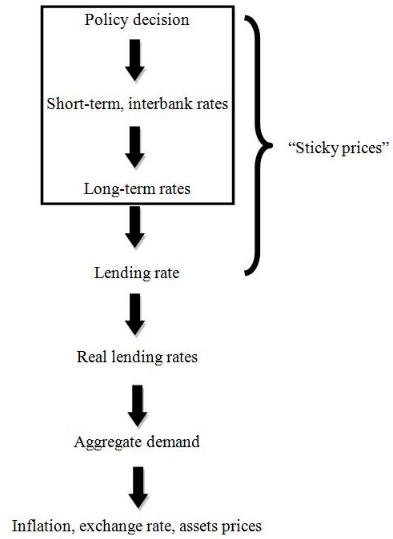
Some economists claimed that the transmission mechanism in these countries is weak, relying on reduced-form analysis capturing the transmission channels in a VAR model (Mishra, Montiel and Spilimbergo, 2012 or Davoodi, Dixit, and Pinter, 2013). Berg and others (2013) argued that analyses based on such empirical models – requiring long time series without policy breaks – are unlikely to ever provide "statistically significant" results in low-income countries and used instead the "narrative approach" of Romer and Romer (1994) to identify textbook effects of transmission mechanism to output and prices.[2]

Our approach is less ambitious in the sense that we focus only on the first part of the monetary transmission mechanism. Monetary policy actions are expected to move the short-term market interest rates. While many central banks use a short-term rate as the policy instrument, other central

[1] See IMF (2015) for a summary.

[2] Christiano, Eichenbaum and Evans (1999) documented theoretical and empirical difficulties in estimating the effects of monetary policy in VARs of developed countries, with long series and a well-defined business cycle.

Figure 1: The Interest Rate Transmission Mechanism



banks change short-term (money market) rates indirectly by setting money growth targets and managing liquidity in line with these targets. According to the Keynesian interest rate channel (Hicks, 1937, Mishkin, 1995), a policy-induced increase in the short-term nominal interest rate leads to an increase in longer-term nominal interest rates as investors arbitrage away differences in risk-adjusted expected returns on debt instruments of various maturities (Figure 1).[3] Under sticky prices, the movements in nominal interest rates then translate into movements in real interest rates and the agents find that their real cost of borrowing has increased over all horizons as a result of the initial short-term rate hike.

In this paper we explore the first leg of the interest rate transmission mechanism: from the short-term rate or policy rate to the long-term bond rates. The three latent factors commonly used to describe the dynamics of the yield curve – the level, slope, and curvature – should explain most of the yield curve variability. Furthermore, in a *well-behaved yield curve* the level shift factor would dominate the slope and curvature factors, ensuring high correlation between the short and long rate moves. In other words, policy hikes/cuts would result in vertical shifts of the yield curve, minimizing

[3] There are, of course, additional links between interest rates and the economy, such as, intertemporal substitution or the effects along the interest-to-exchange-rate nexus.

arbitrage opportunities. To this end, we rely on two complementary empirical techniques to identify the yield curve latent factors and use them as a robustness check. First, the principal component analysis, PCA, initially applied by Litterman and Scheinkman or LS (1991).[4] Second, we corroborate the PCA results by explicitly estimating the three latent factors using the Diebold and Li or DL (2006) methodology. We then inspect whether these two sets of estimated factors are correlated and whether they co-move with monetary policy and interbank rates.

Why do we stop at the long-term bond rates and do not continue to nominal lending rates? Unfortunately, the relevant lending rate series are available only for some industrial countries, while a few emerging market and low-income countries began to collect such series recently.

In the remained of the paper we proceed as follows. First, we outline the modeling techniques to derive the three factors. Second, we describe our sample and discuss the various empirical tradeoffs. Third, we present our results and sketch policy implications. The final section concludes.

2 The Methodology

We apply the LS and DL methodologies to detrended short and long yields to identify the latent factors that govern the movements in the yield curves, following the Diebold, Rudebusch, and Aruoba (2006) approach to explore the first leg of the transmission mechanism (Appendix A). LS finds these factors with the help of the sample covariance matrix of the data, sequentially identifying mutually uncorrelated principal components (PCs). DL employs the Nelson and Siegel dynamic representation of the yield curve, defining a state space model of the yield curve, and applying the Kalman filter to identify the three latent factors, the level, slope, and curvature, labeled β_1, β_2, and β_3. DL is free of the PCA restriction of zero correlation of the factors.[5] Furthermore, while the principal component analysis is designed for stationary data, DL is free of this restriction as well. We assess the

[4] The original U.S. results have been replicated for a number of industrial and a few advanced emerging market countries, such as Mexico (Cortés Espada and others, 2009).

[5] For a primer on both methodologies, see Appendix A. The principal components algorithm (Abdi and Williams, 2010) identifies a PC that accounts for as much of the variance in all underlying data as possible. Then the second PC is identified with the objective of explaining as much as possible of the remaining variance under the constraint that this PC is uncorrelated with the preceding PC (and so on). The PCA zero correlation restriction imposes a signification economic restriction – the level and slope shifts are de-

interest rate channel as follows. First, we compute the share of the variability in the interest rates explained by the latent factors using the LS and DL methodologies.

If the factors explain most of the variability in the actual data across all maturities, we would conclude that the shape of the yield curve and its dynamics are nonstochastic (Appendix [B]). Furthermore, a dominant level shift factor would imply that policy rate moves result in a vertical shift of the yield curve. Second, we inspect correlation among the policy-driven short-term rates and the factors, in particular, the level. We expect to find a positive correlation between the policy rate and the first factor as changes in the former shift the yield curve. Furthermore, assuming that inflation expectations are anchored and long rates reflect country fundamentals, we expect to find a negative correlation between the policy rate and the second factor. In other words, a tighter monetary policy flattens the yield curve and vice versa.

3 Data

Extending yield curve analysis to emerging market and low-income countries proved to be challenging. Data are available for only a handful of countries, securities are rarely traded on secondary markets, and primary issue data are often with gaps. Periods of disinflation (or increasing inflation) have left the series with unit roots, removal of which is not trivial. To rectify this problem, we detrend interest rates and bond yields using the HP-based trend of policy rates. Hence, all interest rates and yields are expressed as term premiums. Furthermore, central banks that follow monetary targets or inflation targeters in low-income countries tend provide liquidity to the banking sector at rates that differ from their declared policy rates.

3.1 Sample countries

We explore the working of the interest rate channel in a sample of 16 countries, that is further divided into emerging market countries, EMC, low-income countries, LIC, and advanced countries, AC (Table 1).[6] The seven

linked by construction. Forzani and Tolmasky (2003) demonstrate that the correlation matrices of yields are very similar across asset classes and countries and the PCs indeed capture the three latent factors.

[6]The selection process for EMCs and LICs was based on data availability and the country making efforts to modernize its monetary framework. See IMF (2014).

EMCs are Egypt (EGY), Georgia (GEO), Indonesia (IDN), Malaysia (MYS), Morocco (MAR), South Africa (ZAF), and Turkey (TUR). The six LICs are Ghana (GHA), Kenya (KEN), Nigeria (NGA), Rwanda (RWA), Tanzania (TZA), and Uganda (UGA). The control group of three ACs comprises the Czech Republic (CZE), Israel (ISR), and Sweden (SWE), all countries practicing inflation forecast targeting (IT) as defined by Svensson (1997). According to the IMF (2012) de facto classification five out of 13 countries in the EMC/LIC group are also IT, however, most of them fail one or more of the Six Principles of Inflation Targeting (Freeman and Laxton, 2009). The sample is macro-economically diverse: average inflation ranged from 1.4 percent in Sweden to almost 15 percent in Ghana, with inflation being higher and more volatile in the EMC/LIC group. The average ex post short-term real interest rate was mostly positive, with a few negative-rate outliers among African countries. The poorest sample country is Uganda and the richest is Sweden. With the exception of Sweden and South Africa, the interest rate series start in the 2000s (Table 2).

3.2 Central bank and interbank rates and yields

All sample countries have treasury bills and bonds of various maturities, interbank money market rates and most have also a central bank interest rate. The latter rate is used differently across the sample, however. While all advanced and some emerging market countries use the central bank rate as a target rate for liquidity operations, most LICs countries occasionally provide liquidity at rates different from their central bank rates (Berg and others, 2013). As a result, the ACs and some EMCs exhibit average spreads between the central bank and interbank interest rates to the tune of tens of basis points, whereas in LICs the spreads are in hundreds of basis points (Figure 2 and also Table 8 in Appendix C). Hence, we use the rate only if the bank has used it consistently as a policy instrument and the interbank rates have been close to the central bank rate. Such conditions are satisfied only among the more advanced IT countries (the Czech Republic, Israel, and Sweden). Hence, we define the monetary policy stance either as the central bank rate or as the shortest maturity, typically overnight, interbank rate.

The monetary policy rate should ultimately affect lending rates, however, this nexus is difficult to demonstrate empirically as the published lending rates in the EMC/LIC group are riddled with problems. First, some countries report as lending rates the so-called prime rate at which little or no retail lending is done. Second, the published data sometimes contain an av-

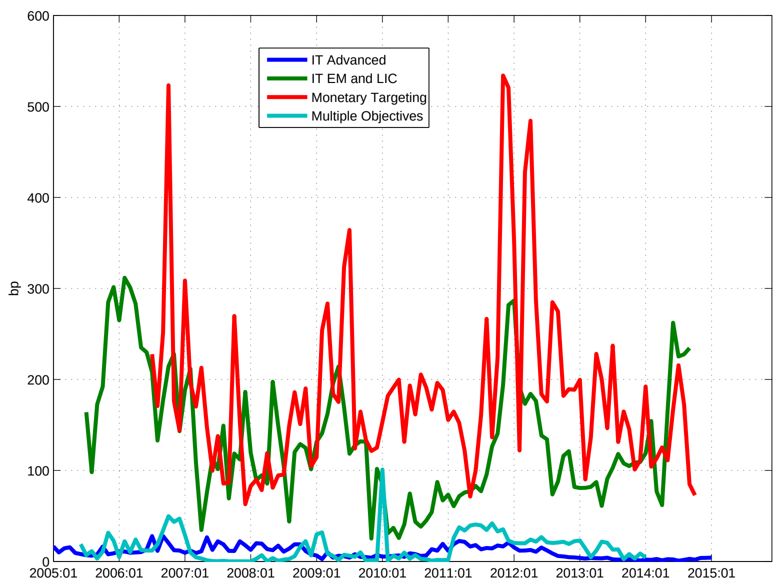
Table 1: Sample Stylized Facts, 2000-2013

Country	MP Regime	Inflation, in percent	Interbank rate, in percent	Per capita GDP, PPP US$
Czech Republic (CZE)	Inflation targeting	2.4	3.4	25,389
Egypt, Arab. Rep. (EGY)	Multiple objectives	8.0	7.0	5,893
Georgia (GEO)	Inflation targeting	5.3	10.4	4,932
Ghana (GHA)	Inflation targeting	14.8	11.6	2,679
Indonesia (IDN)	Inflation targeting	7.5	8.5	4,149
Israel (ISR)	Inflation targeting	2.0	4.1	30,535
Kenya (KEN)	Monetary aggregate targeting	9.6	13.9	1,582
Morocco (MAR)	Monetary aggregate targeting	1.6	6.3	4,554
Malaysia (MYS)	Multiple objectives	2.2	4.4	14,699
Nigeria (NGA)	Monetary aggregate targeting	11.7	15.5	2,293
Rwanda (RWA)	Monetary aggregate targeting	6.9	9.0	1,200
South Africa (ZAF)	Inflation targeting	5.7	3.9	10,105
Sweden (SWE)	Inflation targeting	1.4	2.9	37,498
Turkey (TUR)	Inflation targeting	14.6	10.3	13,110
Tanzania (TZA)	Monetary aggregate targeting	7.6	8.5	1,384
Uganda (UGA)	Monetary aggregate targeting	7.3	10.7	1,275

Source: IMF (2012); *IFS* database.

Figure 2: Spreads Between the Interbank and Policy Rates

Notes: In basis points. The groups are: Advanced IT – Czech Republic, Israel, and Sweden; EMC and LIC IT – Georgia, Ghana, Indonesia, South Africa, and Turkey; Monetary Targeting – Kenya, Morocco, Nigeria, Rwanda, Tanzania, and Uganda; and Multiple Objectives – Egypt and Malaysia.



Source: Authors' calculations.

Table 2: Government Paper and Data Sources

Country	Sample period	Yield type	Maturities
Czech Republic (CZE)	2000M4:2015M1	Yields at issue, primary market (pm), Bloomberg generic for the long tenors	3M, 6M, 1Y, 2Y, 5Y, 10Y
Egypt, Arab. Rep. (EGY)	2006M7:2014M12	T-bills – yields at issue, T-bonds – Bloomberg generic	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
Georgia (GEO)	2010M9:2014M11	Yields at issue, pm	1Y, 2Y, 5Y, 10Y
Ghana (GHA)	2007M1:2014M9	Yields at issue, pm	3M, 6M, 1Y, 2Y, 3Y
Indonesia (IDN)	2005M7:2015M1	Bloomberg generic	1Y, 2Y, 5Y, 10Y, 15Y
Israel (ISR)	2005M1:2015M1	Bloomberg generic	2Y, 3Y, 5Y, 10Y
Kenya (KEN)	2007M1:2014M9	Yields at issue, pm	3M, 6M, 5Y, 10Y, 15Y
Morocco (MAR)	2007M1:2015M1	Yields at issue, pm	3M, 1Y, 2Y, 5Y, 10Y, 15Y
Malaysia (MYS)	2005M1:2014M12	Yields at issue, pm	3M, 6M, 1Y, 2Y, 3Y, 4Y, 5Y, 10Y, 15Y
Nigeria (NGA)	2006M9:2014M10	Yields at issue and yield to maturity, pm and secondary markets	3M, 6M, 1Y, 3Y, 5Y, 10Y
Rwanda (RWA)	2008M1:2014M10	Yields at issue, pm	3M, 6M, 1Y, 3Y
South Africa (ZAF)	1999M12:2014M3	Bloomberg generic	2Y, 3Y, 5Y, 7Y, 10Y, 15Y
Sweden (SWE)	1994M6:2014M12	Bloomberg generic	3M, 6M, 1Y, 2Y, 3Y, 5Y, 10Y
Turkey (TUR)	2007M6:2015M1	Bloomberg generic	3M, 6M, 1Y, 2Y, 5Y, 10Y
Tanzania (TZA)	2003M1:2014M10	Yields at issue, pm	3M, 6M, 1Y, 2Y, 5Y, 7Y, 10Y
Uganda (UGA)	2005M1:2014M12	Yields at issue, pm	3M, 6M, 1Y, 2Y, 3Y, 5Y

Source: Various online databases.

erage rate for all immature loans with a given maturity.[7] Only ACs and some EMCs (Morocco) collect and publish usable series on current-period lending rates, classified by sector, firm size, and maturity, although some LICs (Uganda) start collecting such data. Even for those countries, however, the series are difficult to collect.

Finally, the EMC/LIC lending rates contain sizable credit and inflation premiums. Regarding the former, in Ghana the spread between the prime lending rate and the three-month interbank rate averaged about 2,000 basis points between 2004 and 2013, while in the Czech Republic the spread was only 200-300 basis points. The lending rates reflect the functioning of the domestic asset recovery system: in countries with poor creditor protection lenders charge higher loan-to-deposit spreads than in countries with good protection, to build a buffer against nonperforming loans. Regarding the latter, the inflation premium tends to be sizable in countries with high and volatile inflation, dampening the pass-through from the policy-induced changes in the (nominal) policy rate to the lending rate tends.

We therefore assess transmission mechanism using yield curves that are based on government security market rates, following past literature (Litterman and Scheinkman, 1991; Diebold, Rudebusch, and Aruoba, 2006; Aguiar, Martins, and Soares, 2012). The monthly yields on generic bonds, obtained from the Bloomberg and public databases (Table 2), have drawbacks, however.[8] First, the time series for the EMCs and LICs are short, typically covering only the 2000s. Second, we frequently find only yields at issue on the primary market as the secondary markets are either non-existent or illiquid. The primary market yields are often subject to non-market forces as short maturities are used by the central bank for managing market liquidity and demand for the longer tenors is affected by regulatory measures targeting the capital and liquidity ratios of various financial institutions. Third, the primary market data have missing observations as not all maturities are auctioned at each point in time and we thus intrapolate the missing monthly observations using the Hodrick-Prescott filter with λ=14,400.

The empirical work is further complicated by secular moves in inflation and the corresponding increases/declines in nominal interest rates. Such an un-

[7] For example, a 3-year lending rate is defined as an average of the current-month, 3-year loan rate and rates on immature loans of this maturity issued during the preceding 35 months.

[8] Ideally, we would have liked to estimate zero-coupon yield equivalents for bonds with coupons. Unfortunately, these are regularly available only for advanced countries and estimation thereof for EMCs and LICs is hindered by a lack of benchmark issues.

derlying trend in inflation is likely to bias upward the importance of the level factor. The stationarity assessment is complicated by the fact that individual yields cannot be detrended separately, as the underlying inflation trend should be common across all maturities. To this end, we detrend all yields using the trend of country's monetary policy rate (Hodrick-Prescott filter with λ=14,400), that is, all yields are expressed as term premiums. Still, even after such detrending we cannot reject nonstationarity in one fifth of all yields (Egypt, Georgia, Israel, Morocco, Turkey, Tanzania, and South Africa, Appendix B.). This finding is hardly surprising as our detrended yields are measures of term premiums and these are generally nonstationary (Figure 3).[9]

All yield-curve calculations are performed with monthly data and correlations presented in the paper are sample Pearson product-moment correlation coefficients. For robustness checks we also calculate population correlations, computed from a first-order VAR model. These results are are not materially different from the sample correlations and are available on demand.[10]

4 Results and Policy Implications

A well-functioning transmission mechanism seamlessly transmits monetary policy innovations to longer-term rates.[11] We find evidence of such well-behaved yield curves in our sample countries, basing this conclusion on the latent factors explaining most of the variability across all maturities. Furthermore, the factors are correlated with policy interest rates. Regarding robustness, first, we check the explanatory power of the LS and DL estimates of latent factors and compare the two techniques. Second, we discuss the links between the monetary policy rates and the first two factors. All checks suggest that our results are methodology invariant.

4.1 The LS and DL Estimates of the Latent Factors

The LS and DL estimates of the latent factors are highly correlated in most of the sample countries despite the different identifying restrictions and we

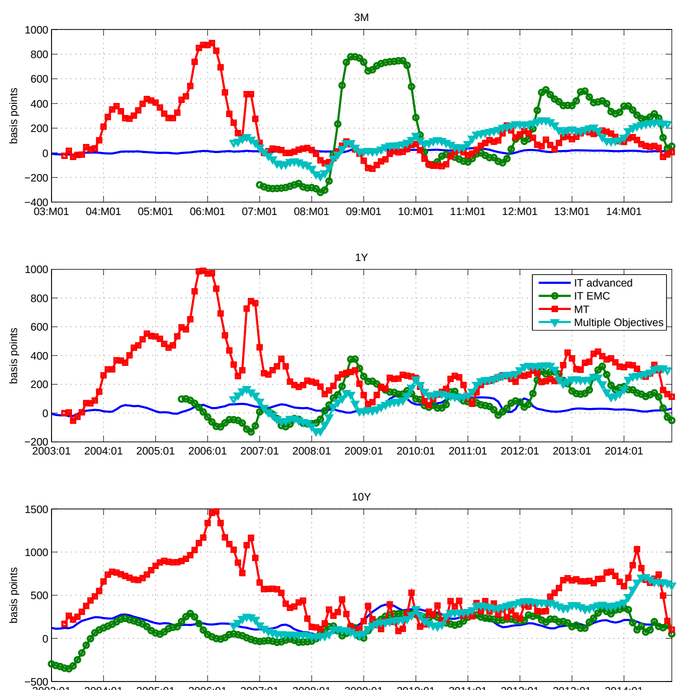
[9]See e.g. Kim and Orphanides, 2007; Adrian, Crump, and Moench, 2013.

[10]Detailed, country-specific results are posted at www.ales-bulir.wbs.cz.

[11]Of course, correlations are not an evidence of causality. For example, a central bank can instantaneously map long-term rate developments into its policy rate and, indeed, there is some anecdotal evidence of such behavior in some non-IT emerging market central banks. We are indebted to Doug Laxton for bringing such behavior to our attention.

Figure 3: Average Term Premiums: Countries Grouped by Their Monetary Policy Regimes

Notes: Detrended yields at 3-month, 1-year, and 10-year maturities: yield minus the detrended policy rate (λ=14,400). The policy rate is the central bank rate in ACs and the shortest maturity, typically overnight, interbank rate in the rest of the sample. The groups are: Advanced IT – Czech Republic, Israel, and Sweden; EMC and LIC IT – Georgia, Ghana, Indonesia, South Africa, and Turkey; Monetary Targeting – Kenya, Morocco, Nigeria, Rwanda, Tanzania, and Uganda; and Multiple Objectives – Egypt and Malaysia.



Source: Authors' calculations.

Table 3: Factor Comparison Between the LS and DL Methodologies

Notes: Sample correlation coefficients of the latent factors: the first, second, and third factors are labeled as the level, slope, and curvature. Statistically significant coefficients – at the 95 percent confidence interval – are highlighted in gray. A correlation coefficient larger than 0.4 is considered as indicating strong correlation (Doucouliagos, 2011).

	First	Second	Third
CZE	0.5	1.0	0.0
EGY	0.9	1.0	0.7
GEO	1.0	0.6	0.6
GHA	0.6	0.8	0.8
IDN	1.0	0.9	0.7
ISR	0.4	0.7	−0.2
KEN	0.9	1.0	0.0
MAR	0.9	1.0	0.9
MYS	0.6	0.8	0.4
NGA	0.9	0.5	0.6
RWA	0.5	0.9	0.6
SWE	0.3	1.0	0.6
TUR	0.8	0.5	0.2
TZA	0.7	1.0	0.6
UGA	0.6	0.9	0.5
ZAF	0.9	0.7	0.3

Source: Authors' calculations.

thus consider these estimates to be robust (Table 3). By extension, as the DL-based factors have clear structural interpretation as the level, slope, and curvature, the LS-based estimates can be labeled in the same way.

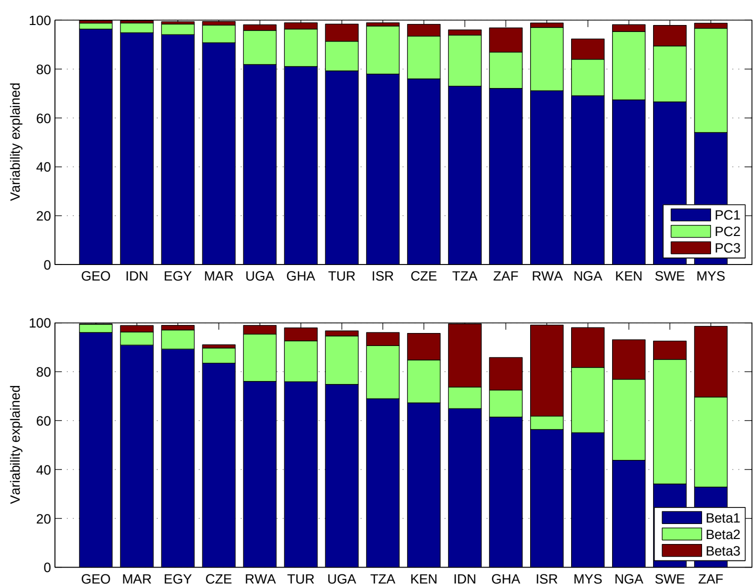
Jointly the three factors explain more than 95 percent of the interest rate variability in all countries, with an exception of Nigeria, and the first two factors account for most of yield variability (Figure 4). Assessing the *average* explanatory power of the level and slope factors jointly across different maturities does not suggest any material differences – the two factors explain on average 95 percent of the yield variance. The first latent factor, the level, is a crucial indicator of transmission as it measures the vertical shifts of the yield curve and it clearly dominates in most countries.[12] High contribution of this factor implies that the yields are correlated across maturities and, hence, innovations are quickly propagated. Of course, interest rate innovations may be propagated also through changes in the slope of the

[12]In some countries a relatively high share of variability attributed to the first factor may be related to the presence of a trend in the data even after detrending (Egypt, Indonesia, and Morocco). The high explanatory power of the level factor in the case of Georgia might be partly caused by a very short series.

yield curve, especially if inflation expectations are anchored. To this end, we find that Sweden and South Africa, both inflation targeting countries, exhibit comparatively low contribution of the level factor. The contribution of noise and stochastic (unexplained) parts of yield curve variability is estimated to be fairly small. From this perspective, we find yield curves to be (i) well behaved in both developed and low income countries and (ii) difficult to differentiate the ACs from EMCs and LICs, that is, regime invariant. In other words, our sample countries behave very much in line with the theory of term structure of interest rates, with relatively small shocks to the term structure (see Appendix A for Monte Carlo simulations).

Figure 4: Interest Rate Variability Explained by Three Factors Using the LS and DL Methodologies

Notes: The height of each bar in the upper chart indicates the proportion of total variance of yields explained in percent by the first, second, and third PCs (LS). The height of each bar in the bottom chart indicates the proportion of total variance of the sample country interest rates explained by the estimates of the βs (DL). For example, the proportion of explained variance by each PC (LS) for Uganda(UGA) is 81.8 percent, 14.0 percent, and 2.3 percent, respectively, cumulatively explaining 98.1 percent of variance in Ugandan yields. The contribution of the βs are proxied by the relative contribution of their shocks to the variance of observed yields.



Source: Authors' calculations.

We find two major differences between the advanced IT countries and the rest of the sample. First, the contribution of the level factor declines at the 5-year and 10-year maturity in all three advanced countries, that is, the common innovations do not transmit to the longest maturities (see full dark blue line in Figure 5). This finding indicates that the long maturities in AC inflation targeters are anchored by a credible inflation target and do not need to react to policy shocks. Central banks in the rest of the sample lack such a credible anchor and the contribution of the level factor remains high at longer maturities. In other words, while in the ACs the yield curves move vertically and become flatter (pivot) at longer maturities after a policy shock, in the rest of the sample we observe mostly the vertical shift.

Second, the contribution of the level factor is small at short tenors in the sample of monetary targeters and EMC/LIC inflation targeters – the 3-month, 6-month, and 12-month interbank rates do not move with the rest of the yield curve (see light blue line with triangle markers in Figure 5). Our interpretation is that the central banks in these countries do not have complete control over the short end of the yield curve and the level factor explains thus relatively little of the variability of short tenors. The lack of control can be attributed, first, to monetary targets that determine the short-term rates residually and, second, to the earlier discussed unwillingness of some central banks to synchronize their policy rates with rates at which liquidity operations are executed.

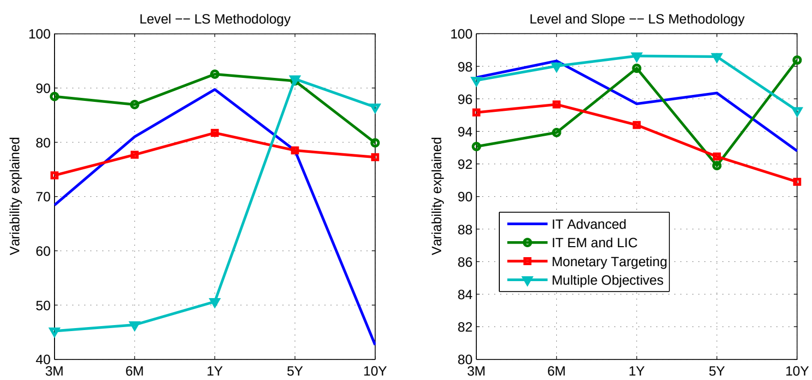
Grouping countries into AC, EM, and LI suggests only small differences in explained variability (Figure 6). The first two factors explain on average 96 percent of yield variance in ACs and EMCs, declining to 92 percent in LICs. Breaking down the sample by maturity points again to the credibility issue in the EMCs and LICs as long-term yields do not appear to be anchored by the inflation targets. We take these results as suggesting that advanced IT countries are more likely to have well-behaved yield curves than less developed countries, irrespective of their income level. The summary differences are fairly small and fail to make a strong case for developed secondary financial markets in order to obtain a meaningful yield curve, presumably because commercial banks are the main buyers and sellers of central bank and government paper in EMCs and LICs.

4.2 The Short-term Rates and Factors

We proceed to explore how well are policy rate hikes/cuts reflected in the longer-term rates by examining, first, the correlations between the actual

Figure 5: LS Variability Attributed to the Level and Slope: Countries Grouped by Their Monetary Policy Regimes

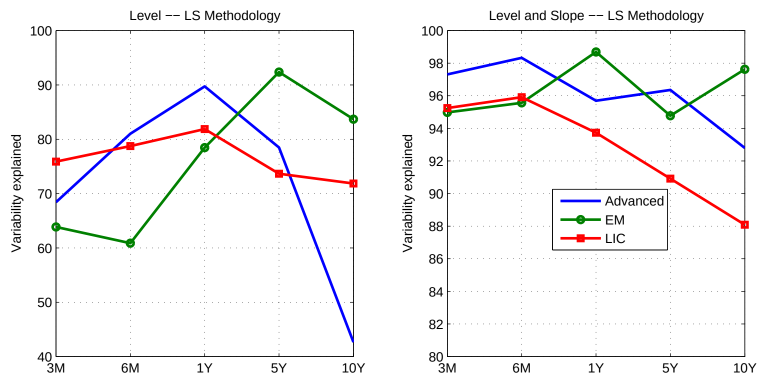
Notes: The variability explained by the slope and level factors is expressed in percent across different maturities. A country is excluded from the computation if the specific maturity is not observed. The groups are: Advanced IT – Czech Republic, Israel, and Sweden; EMC and LIC IT – Georgia, Ghana, Indonesia, South Africa, and Turkey; Monetary Targeting – Kenya, Morocco, Nigeria, Rwanda, Tanzania, and Uganda; and Multiple Objectives – Egypt and Malaysia.



Source: Authors' calculations.

Figure 6: LS Variability Attributed to the Level and Slope: Countries Grouped by the Level of Economic Development

Notes: The variability explained by the slope and level factors is expressed in percent across different maturities. A country is excluded from the computation if the specific maturity is not observed. The groups are: AC – Czech Republic, Israel, and Sweden; EMC – Egypt, Georgia, Indonesia, Morocco, Malaysia, South Africa, and Turkey; and LIC – Ghana, Kenya, Nigeria, Rwanda, Tanzania, and Uganda.



Source: Authors' calculations.

interest rates and the estimated latent factors and, second, the shape of the PCA loadings. While neither technique proves causality from to policy to long-term rates, the alternative of the policy rate passively reflecting long-term bond rate movements is inconsistent with the forward-looking behavior of the sample central banks. Diebold, Rudebusch, and Aruoba (2006) argued that these correlations are unlikely to be driven by a third variable. Our results strongly suggest that changes on the short end of the yield curve have a powerful impact on long-term yields.

First, we show how the monetary policy rates interacts with the yield curves. All correlations between the monetary policy rates and the shortest available maturity yield are positive (Table 4, first column). In particular, the correlations are high among the IT countries.[13] Furthermore, monetary policy rates are positively correlated with the level factors identified using LS in most of countries, however, for a few IT countries we found negative correlations using the DL methodology (Table 4, second column). We also find the expected negative correlation coefficients between the policy rates and the

[13]The low correlation coefficient in South Africa is driven by the fact that the shortest maturity available in our sample is 2-year.

Table 4: Correlations Between Monetary Policy Rates and Yields, and Factors

Notes: Sample correlation coefficients. Statistically significant coefficients – at the 95 percent confidence interval – are highlighted in gray. The first block reports correlations between the monetary policy rate and the shortest available maturity available. The "Level" block reports correlations between the monetary policy rates and the level factor, using the LS and DL estimates of the factors, respectively. The "Slope" block reports correlations between the monetary policy rates and the slope factor.

	Shortest Mat.	Level LS	Level DL	Slope LS	Slope DL
CZE	0.9	0.7	−0.0	−0.6	−0.6
EGY	0.5	0.3	0.2	−0.6	−0.6
GEO	0.3	0.5	0.6	0.4	0.7
GHA	0.8	0.8	0.2	−0.4	−0.6
IDN	0.8	0.7	0.6	−0.3	−0.5
ISR	0.7	0.5	−0.1	−0.5	−0.7
KEN	0.8	0.4	0.2	−0.7	−0.6
MAR	0.3	0.1	0.1	−0.2	−0.2
MYS	0.9	−0.2	−0.7	−0.9	−0.8
NGA	0.3	0.4	0.5	0.2	0.2
RWA	0.9	0.8	0.5	−0.1	−0.3
SWE	0.9	0.6	−0.3	−0.7	−0.8
TUR	0.4	0.4	0.1	−0.6	−0.4
TZA	0.4	0.3	−0.0	−0.4	−0.4
UGA	0.8	0.6	0.0	−0.6	−0.6
ZAF	0.2	−0.0	−0.3	−0.6	−0.6

Source: Authors' calculations.

slope in all countries, except in Nigeria. Of course, not all correlations between the policy rates and the later factors have to be statistically significant – in some countries policy moves are reflected mostly in vertical shifts of the yield curve, while in others the yield curve pivots (for example in multiple objective countries).

Second, we assess the loading factors. In all sample countries, the level loadings are essentially constant at about 0.4-0.6, suggesting that all observed maturities enter the first factor with similar weights (the full blue line labeled PC1 in Figure 7 and 8). The only exceptions are Rwanda, where the loadings level off at the 1-year maturity, and Malaysia, where the loading is close to zero for short maturities up 2 years. The estimated second and third latent factors also have the expected properties (see the green and red lines, respectively). The loadings of the second principal component are either downward or upward sloping across maturities, proxying the slope of the yield curve and the factor is correlated with the empirical measures of the slope.[14] The loadings of the third principal component approximate the convex/concave curvature of the yield curve.

Turning to individual countries, the first factor is positively correlated both with the empirical short and long-term yields in all 16 countries (Appendix D). As before, we find no material differences among the sample countries, either for short or long tenors, interpreting these findings as supporting our hypothesis that the interest rate transmission mechanism is present in all sample countries.

Policy-induced interest rate moves are correlated with the vertical shifts of the yield curve, however, such moves may affect also the slope of the yield curve. As expected, the first and second latent factors are positively correlated and most of these correlations are statistically significant. In other words, monetary tightening/loosening pivot the yield curve, in addition to the level shift (see the first column in Table 5).[15] As before, we fail to observe any systematic differences between the advanced and low income countries. In contrast, the correlations between the first and third and between the second and third latent factors are small and change signs.

4.3 Policy Implications

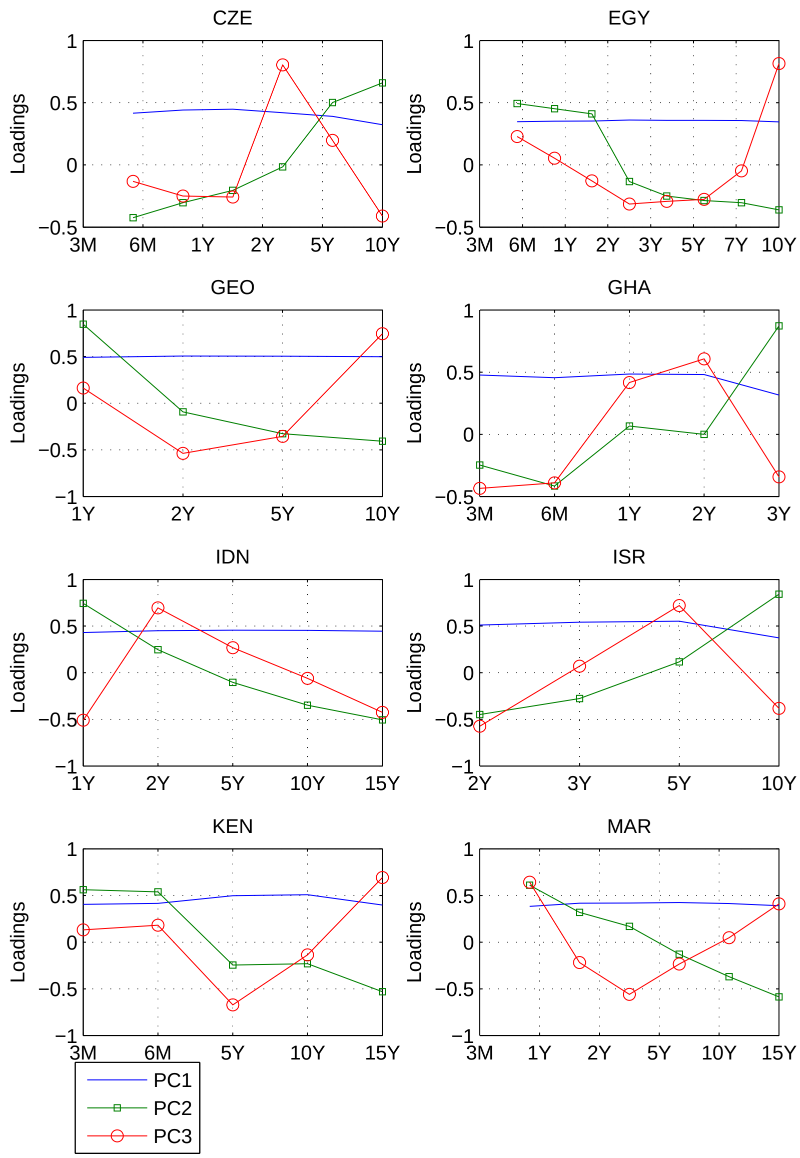
Our sample findings have useful policy implications and we summarize them into five sets. First, we find a strong co-movement between the policy rate and bond yields, suggesting well-behaved yield curves without arbitrage opportunities. Such a yield curve is a necessary, if not sufficient, condition for monetary transmission. Second, for countries that use their policy rate as a monetary policy instrument, we find a strong link between such a rate and short-term interbank or treasury bill rates. Third, we find a number of intuitive results linked to the credibility of the policy regime and the level of development. Only in advanced countries – all practicing inflation forecast targeting – inflation expectations are anchored and the long rates thus react less to the first (level) factor than in the other countries. Conversely,

[14] The empirical measures of the level, slope, and curvature are the yields of securities with the shortest and the longest maturity in the sample; the long-to-short difference of these maturity extremes; and double of the yield on maturity in the middle of the extremes minus the sum of yields on those extreme maturities, respectively.

[15] These results are based on the DL methodology, as the LS-based latent factors are by construction orthogonal.

Figure 7: Principal Component Loadings

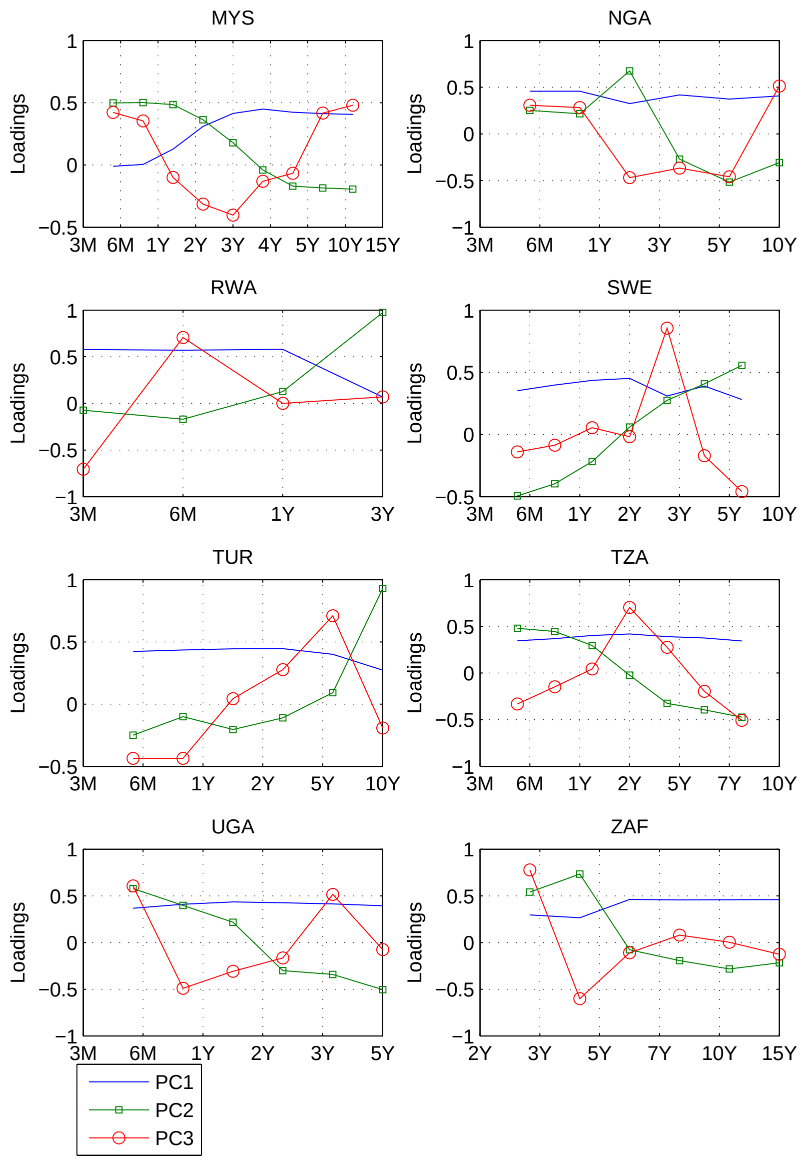
Notes: The loadings of the first factor (level) are denoted with the solid blue line; the loadings of the second factor (slope) are denoted with the green squares; and the loadings for the third factor (curvature) are denoted with the red circles.



Source: Authors' calculations.

Figure 8: Principal Component Loadings

Notes: The loadings of the first factor (level) are denoted with the solid blue line; the loadings of the second factor (slope) are denoted with the green squares; and the loadings for the third factor (curvature) are denoted with the red circles.



Source: Authors' calculations.

Table 5: Correlations Among the Latent Factors (DL)

Notes: Pairwise correlation coefficients among the three latent factors (the level, slope, and curvature) obtained from the DL methodology. Statistically significant coefficients – at the 95 percent confidence interval – are highlighted in gray.

	First&Second	First&Third	Second&Third
CZE	0.7	−0.2	−0.4
EGY	0.2	0.1	0.3
GEO	0.9	0.6	0.6
GHA	0.5	−0.5	−0.5
IDN	0.1	−0.2	0.0
ISR	0.4	−0.6	0.1
KEN	0.5	−0.2	−0.4
MAR	0.4	−0.0	−0.2
MYS	1.0	−0.6	−0.6
NGA	−0.1	0.2	0.5
RWA	0.6	−0.1	−0.2
SWE	0.8	−0.1	−0.2
TUR	0.6	−0.5	−0.3
TZA	0.7	0.1	−0.1
UGA	0.7	−0.1	−0.1
ZAF	0.5	0.2	0.8

Source: Authors' calculations.

the level shift matters equally for all maturities in the EMC/LIC sample. Furthermore, monetary targeters and EMC/LIC inflation targeters have incomplete control over the short end of the yield curve and the level factor explains less of the variability of short tenors as compared to AC inflation targeters.

Fourth, transmission gains from deeper secondary markets in ACs appear surprisingly small. Or to put it differently, deep secondary markets do not seem to be absolutely necessary for a well-behaved yield curve, presumably on the account of commercial banks being the main buyers and sellers across all maturities. Finally, the link between short rates and lending rates in EMCs and LICs remains a topic for future research as series on meaningful loan rates are unavailable but for a few advanced countries. Such rates would allow extending the transmission mechanism for the "lending nexus" .

5 Conclusions

We find a well-behaved yield curve of bond yields in advanced, emerging, and low-income countries, indicating a working interest rate transmission channel in all of our sample countries. The three latent factors – the level, slope, and curvature – explain the bulk of interest rate moves, and the vertical shift dominates. The link from policy/interbank rates to bond yields appears to be robust across estimation techniques and largely unaffected by the monetary policy regime or the stage of economic development. We find no evidence that well-developed secondary markets supercharge the transmission mechanism as commercial banks do most of the trading of government paper in low-income countries. Furthermore, we find only weak evidence that the transmission mechanism operates more smoothly in more developed countries practicing inflation targeting than in less developed countries. These results are broadly invariant to the methodologies used and they are also remarkably consistent across the sample countries, despite short samples, gaps in longer maturities, monetary policy regimes, and so on.

The findings of this paper have a strong policy implication – the presence of the first leg of the monetary transmission is broadly independent of the level of financial sophistication. To the extent that advanced inflation targeting countries appear to have marginally better-behaved yield curves than countries that follow other objectives, the functioning of the transmission mechanism seems partly a matter of domestic choice and credibility thereof. These results are relevant as the sample central banks continue to gauge their ability to steer the economy with indirect instruments. The overall message is clear – the central bank actions do matter even in low income countries.

A Primer on Yield Curve Methodologies

The paper replicates the LS principal component analysis and DL methodology to capture the dynamics of the sample-country yield curves. Both approaches characterize the movements of the yield curves by identifying three latent factors labeled as the level, slope, and curvature. We briefly describe both methodologies and list the relevant references.

Principal Component Analysis

Principal component analysis (PCA) is a well established method for reducing data dimensionality. It transforms the multiple observed series into a set of uncorrelated principal components. As the interest rate series are correlated, one should be able to capture their variability with fewer principal components than what was the count of the observed series.

Let us assume that the data are collected in an $X(m{\times}n)$ matrix, where the n columns are the observations and the m rows are the variables (yields). PCA finds a transformation matrix $W(m \times m)$ such that it projects X into principal components $P^C(m \times n)$:

$$P^C = WX, \tag{1}$$

choosing W such that the rows of P^C are uncorrelated with each other and hold the same information as the original matrix X. The rows of P^C are ordered in a descending order according to their importance as there are a total of m principal components. It can be shown that in order to fulfill the objectives above, the rows of W are the eigenvectors of the covariance matrix, XX^T, and W is called the matrix of factor loadings.

We follow Litterman and Scheinkman (1991) who applied PCA to observed yields. The data are normalized by dividing each maturity yield by its sample standard deviation, interpolating missing data with the Hodrick-Prescott filter. Principal components are ordered in a descending order by the total variance explained and the first, second, and third principal components are labeled as the level, slope and curvature factors of the yield curve.

The Diebold and Li Framework

Diebold and Li (2006) suggested a modification to the Nelson and Siegel exponential component framework to fit yield curves. The DL framework uses three time-varying parameters, which can be interpreted also as the level, slope, and curvature. These unobserved parameters are identified based on the data and mean square error optimization, after imposing simple structural restrictions. The state-space representation along with Kalman filtration allow for missing observations.

In our version the yield curve follows:

$$y_t(\tau) = \beta_{1t} + \beta_{2t}\left(\frac{1-\exp^{-\lambda\tau}}{\lambda\tau}\right) + \beta_{3t}\left(\frac{1-\exp^{-\lambda\tau}}{\lambda\tau} - \exp^{-\lambda_t\tau}\right), \tag{2}$$

where $y_t(\tau)$ is the yield at time t of a bond with maturity τ. β_{1t}, β_{2t}, and β_{3t} are the time-varying parameters (or factors) and λ are country-specific parameters driving the exponential decay rate. Following Diebold and Li (2006), we set λ based on countries' average maturity of government paper.

DL show that the parameter β_1 can be interpreted as a level shift, as it increases all maturity yields equally. The parameter β_2 is closely related to the slope of the yield curve. The loading on this parameter, $\frac{1-\exp^{-\lambda\tau}}{\lambda\tau}$, is between 0 and 1. The parameter β_3 describes the curvature: its loading, $\frac{1-\exp^{-\lambda\tau}}{\lambda\tau} - \exp^{-\lambda_t\tau}$, starts at 0, increases up to a certain maturity, and gradually decays afterward.

In order to identify unobserved time-varying parameters, we transformed the model to a state-space form following Diebold, Rudebusch, and Aruoba (2006). The transition equations driving the dynamics of yields are:

$$\begin{bmatrix} y_t(\tau_1) \\ y_t(\tau_2) \\ \vdots \\ y_t(\tau_N) \end{bmatrix} = \begin{bmatrix} 1 & \frac{1-\exp^{-\lambda\tau_1}}{\lambda\tau_1} & \frac{1-\exp^{-\lambda\tau_1}}{\lambda\tau_1} - \exp^{-\lambda\tau_1} \\ 1 & \frac{1-\exp^{-\lambda\tau_2}}{\lambda\tau_2} & \frac{1-\exp^{-\lambda\tau_2}}{\lambda\tau_2} - \exp^{-\lambda\tau_2} \\ \vdots & \vdots & \vdots \\ 1 & \frac{1-\exp^{-\lambda\tau_N}}{\lambda\tau_N} & \frac{1-\exp^{-\lambda\tau_N}}{\lambda\tau_N} - \exp^{-\lambda\tau_N} \end{bmatrix} \begin{bmatrix} \beta_{1t} \\ \beta_{2t} \\ \beta_{3t} \end{bmatrix} + \begin{bmatrix} \varepsilon_t(\tau_1) \\ \varepsilon_t(\tau_2) \\ \vdots \\ \varepsilon_t(\tau_N) \end{bmatrix}. \tag{3}$$

The factors, β_i's, are assumed to be random-walk processes:

$$\begin{bmatrix} \beta_{1t} \\ \beta_{2t} \\ \beta_{3t} \end{bmatrix} = \begin{bmatrix} \beta_{1t-1} \\ \beta_{2t-1} \\ \beta_{3t-1} \end{bmatrix} + \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \end{bmatrix}, \tag{4}$$

where ε and η are white noise shocks with zero means and covariance matrices Q and H:

$$\begin{pmatrix} \varepsilon_t \\ \eta_t \end{pmatrix} \backsim WN \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} Q & 0 \\ 0 & H \end{pmatrix} \right]$$

The measurement equations then link the observed yields with state variables assuming no measurement errors:

$$\begin{bmatrix} y_t(\tau_1) \\ y_t(\tau_2) \\ \vdots \\ y_t(\tau_N) \end{bmatrix} = \begin{bmatrix} y_t^{obs}(\tau_1) \\ y_t^{obs}(\tau_2) \\ \vdots \\ y_t^{obs}(\tau_N) \end{bmatrix}. \qquad (5)$$

We match the state-space model with the data using the Kalman filter. For each country we estimate matrices Q and H using the Bayesian estimation techniques with inverse gamma distribution of priors.

We simplify the original DL framework in three aspects, without loosing any of its structural advantages. First, we reduce the number of estimated parameters by filtering the noise in the data via the error terms, ε's, rather than by treating measurement errors explicitly. Second, we impose the random walk processes for the latent factors. Third, we do not allow for cross-factor dynamics and correlations. The last two simplification follow Diebold, Rudebusch, and Aruoba (2006) who found factors to be highly persistent with insignificant cross-factor dynamics.

Assessing Yield Curves Using LS and DL Methodologies

The LS and DL methodologies are commonly used to fit yield curves and we argue that they can be used to assess the transmission of short-term to long-term rates along the yield curves. We consider a yield curve to be "well behaved" if short-term interest rates transmit to long tenors in line with the expectation theory of term structure implying that a long-term yield adjusted for a term premium has to be equal to expected short-term yields compounded to the same maturity. As a result, there will be nonzero correlation between long-term and short-term yields. Lord and Pelsser (2005) derive sufficient conditions for a correlation matrix under which the level, slope, and curvature are jointly present. However, we use the LS and DL methodologies instead of correlation analysis, as these methodologies provide an easy decomposition into the level, slope, and curvature shifts. These shifts can be easily crosschecked with monetary policy actions.

One may wonder, however, whether the LS and DL methodologies are too general so that one always obtains the same type of latent factors. In order to demonstrate how the LS and DL methodologies can be used for assessing the yield curves, we generated artificial yield curve data using Monte Carlo simulations. The data were generated by a workhorse gap model similar to Berg, Karam, and Laxton (2006) augmented with the expectation theory of interest rates.[16] Using the model, we generated yield samples and conducted our analysis. First, we generated artificial yields by assuming a common set of business cycle shocks (short-term demand, supply, exchange rate, and policy shocks; long-term inflation target and country risk premium shocks) without any shocks to term structure of interest rates. Second, we did the same exercise with the term structure shocks explaining about 25 percent and 50 percent of yield variability. Finally, we generate yields as white noise.

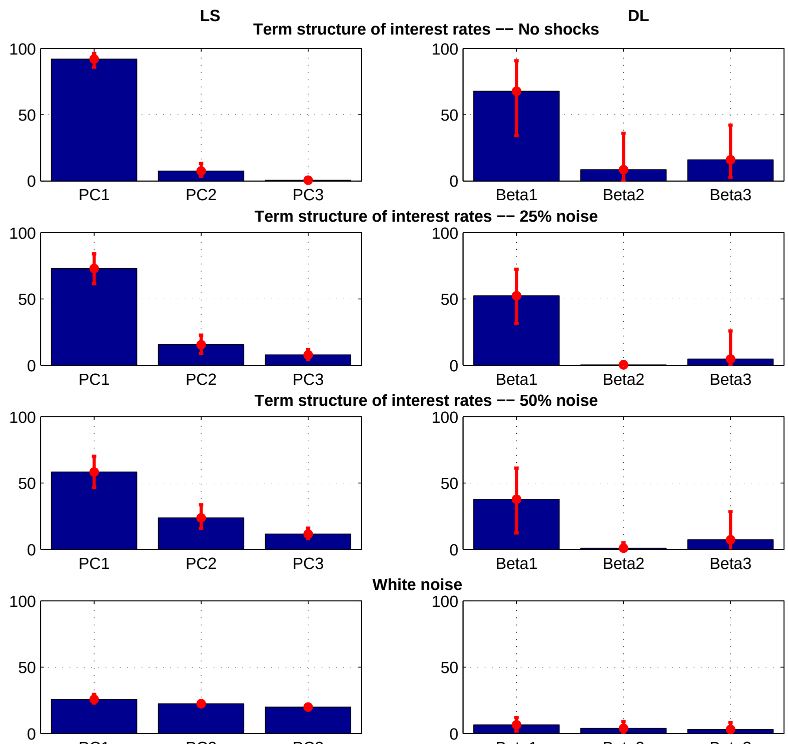
The results suggest that interest rate variability in our Monte Carlo simulations – for a plausible setup of term-structure shocks being equivalent to 25 to 50 percent of yield variability – is mostly explained by the first factor, much as in the actual sample (Figure 9).[17] As expected, the contribution of the first factor declines with the magnitude of term-structure shocks. The first two factors explain more than 90 percent of observed interest rate variability in the case of the pure term structure (both LS and DL) and in the case of 25-50 percent noise contribution in addition to the term structure (LS), see the top three left-hand-side charts. The explained share, especially for the first factor, is somewhat lower for the DL methodology. In the extreme case of white noise data, the variability explained by any factor is very low (bottom row). Based on these results, we conclude that well-behaved yield curves are mirrored in LS and DL methodologies: first, level is the leading factor as measured by its explanatory power and, second, level and slope together explain most of the variability in the data.

[16] We used a generic calibration for a small open economy with a floating currency and an explicit inflation target. The yield curve simulations are robust to parameter changes.

[17] Abbritti and others (2013) decomposed yield curve variability in a FAVAR framework and their results make us believe that the above contribution to yield variability is a good rule of thumb for small open economies.

Figure 9: Variability Explained Using LS and DL Methodologies (Monte Carlo Simulations)

Notes: The LS and DL methodologies shown in the left and right columns, respectively, are applied on artificial data generated by a structural model of business cycle augmented with the term structure of interest rates using a 1,000-draw sample. In the first row we show results for the model with a standard set of business cycle shocks without any white-noise shocks to the term structure of interest rates. In the second and third rows we add term structure shocks, calibrating their standard deviations to be equivalent to about 25 percent and 50 percent of yield variability, respectively. In the final row we generate an artificial sample of white-noise yields. The variability explained by each factor is reported on horizontal axis in percent, with the red line indicating the 95 percent confidence interval.



Source: Authors' calculations.

Table 6: Augmented Dickey-Fuller Tests for Detrended Series

Notes: Rows denote countries and columns maturities. Three, two, and one star mean the null hypothesis of stationarity can be rejected at the 99 percent, 95 percent, and 90 percent confidence interval, respectively. "N.Rej." means that the null hypothesis of unit root cannot be rejected. Empty spaces indicate that the maturity is not available for this country.

	3M	6M	1Y	2Y	3Y	4Y	5Y	7Y	10Y	15Y
CZE	**	**	**	***			***		**	
EGY	*	*	*	N.Rej.	N.Rej.		N.Rej.	N.Rej.	N.Rej.	
GEO			***	**			**		N.Rej.	
GHA	**	**	**	**	*					
IDN			***	***			***		***	**
ISR				***	***		**		N.Rej.	
KEN	***	***					**		***	***
MAR	*		N.Rej.	N.Rej.			N.Rej.		N.Rej.	N.Rej.
MYS	***	***	***	***	***	**	**		**	**
NGA	**	**	*		**		**		**	
RWA	***	***	**		***					
SWE	***	***	***	***	***		***		***	
TUR	**	**	**	**			**		N.Rej.	
TZA	***	***	***	**			N.Rej.	N.Rej.	N.Rej.	
UGA	***	**	**	*	**		**			
ZAF				***	***		*	*	N.Rej.	*

B Series Properties and Robustness Checks

ADF tests

Most countries in our sample contain a trend in inflation, typically as a results of past disinflation and, hence, we find also a trend in the in central bank rate series. Therefore, the data have to be detrended, otherwise the presence of a unit root would affect the correlation matrixes. We detrend the data using trends in the domestic monetary policy rate (either the central bank rate or the interbank rate), in effect re-defining all series as term premiums. The trend of monetary policy rate is identified using the HP filter. The Augmented Dickey-Fuller tests show that we can reject the null hypothesis of stationary series for most but not all of the detrended yields (Table 6).

Latent factor correlations

The LS and DL estimates of factors are highly correlated in most sample countries despite different identification techniques. The first factor estimates are strongly correlated in all countries, except in Rwanda. The same holds for the second factor, except Israel, Nigeria, South Africa, and Turkey. The evidence is mixed for the third factor: the correlations are high mostly in low income countries which exhibit unit roots even after detrending (Egypt, Morocco, and Malaysia).

Factors and their empirical counterparts

In order to check robustness of the latent factors, we compared them with the commonly used empirical measures of level, slope, and curvature. The first factor is positively correlated both with the short and long-term yields in all 16 countries, suggesting that the first factor is a good proxy of the level shift and that it affects all maturities along the yield curve.

C Central Bank and Interbank Rates

All sample countries have interbank money markets and most have also a policy interest rate. However, the latter instrument is used differently across the sample (Table 8). All advanced and some emerging market countries used the policy rate as a target rate for liquidity operations. As a result, these countries exhibit very high correlation between policy and interbank interest rates, see Table 8. For example, in the Czech Republic the one-day interbank rate has been on average higher by only 14 basis points than the policy rate of the Czech National Bank (the two-week repo rate). Only at the height of the 2008 financial crisis the spread temporarily widened to 100 basis points.

In contrast, most LICs countries periodically provided liquidity at rates different from their policy rates. For example, in Ghana the policy rate and the main liquidity instrument, approximated by the 30-day Bank of Ghana bill, stayed periodically far apart: while between mid-2005 and end-2007 liquidity was made available to commercial banks on average 270 basis points *below* the policy rate, during 2013 it was made available some 600 basis point *above* the policy rate. As the effective liquidity rate differed from the policy rate in these countries, correlation between policy and interbank rates was low.

Table 7: Factor Correlations with Empirical Yields

Notes: Sample correlation coefficients of the first two latent factors with the empirical measures of the level and slope. The first two columns contain correlations among the level factor and empirical yields, both short and long, while the third columns contains correlations among the slope factor and the empirical slope measure.

	Shortest Maturity		Longest Maturity		Slope (Long−Short Maturities)	
	LS	DL	LS	DL	LS	DL
CZE	0.9	0.2	0.7	0.9	0.1	0.7
EGY	1.0	0.9	1.0	1.0	0.4	0.1
GEO	1.0	0.9	1.0	1.0	0.2	0.9
GHA	1.0	0.5	0.6	0.7	−0.6	0.2
IDN	0.9	0.8	1.0	1.0	−0.2	0.2
ISR	0.9	0.0	0.7	0.9	−0.2	0.9
KEN	0.7	0.5	0.9	1.0	−0.0	0.6
MAR	0.9	0.7	0.9	1.0	0.7	0.3
MYS	−0.0	−0.8	0.9	0.6	0.7	0.9
NGA	0.9	0.7	1.0	1.0	−0.8	0.1
RWA	1.0	0.5	0.6	1.0	−0.5	1.0
SWE	0.8	−0.2	0.6	0.9	−0.1	0.8
TUR	0.9	0.6	0.9	1.0	−0.4	0.6
TZA	0.8	0.2	0.8	1.0	−0.0	0.6
UGA	0.8	0.3	0.8	0.9	−0.4	0.5
ZAF	0.7	0.4	1.0	1.0	0.7	0.6

Source: Authors' calculations.

Table 8: Central Bank and Interbank Rates

Country	Policy rate and liquidity operations	Root mean square difference (basis points)	Range
Czech Republic (CZE)	Liquidity operations conducted at the central rate – **2W repo rate**. The interbank rate (**1D PRIBOR**) close to the central bank rate.	14	2002M1–2015M1
Egypt, Arab. Rep. (EGY)	A corridor with overnight deposit and lending facility since June 2005 and the **repo rate** in the center of the corridor since March 2013. However, **the overnight interbank rate** close to the overnight deposit rate.	33	2005M6–2014M11
Georgia (GEO)	The **refinancing rate** introduced as a central bank rate in 2008. The **overnight interbank rate** close to the refinancing rate since the second half of 2010.	134	2008M2–2014M12
Ghana (GHA)	Liquidity operations and the **central bank rate** were periodically disconnected. As a result, the **interbank rate** differed from the central bank rate.	266	2004M2–2014M9
Indonesia (IDN)	The **interbank JIBOR rate** deviates from the central bank rate – the **interbank rate**.	183	2005M7–2015M1
Israel (ISR)	**Bank of Israel interest rate** is used for with liquidity operations and is closely followed by the **interbank rate**.	20	2001M1–2014M12
Kenya (KEN)	The central bank rate was used since July 2006, but it remained disconnected from liquidity operations. As a result, the **interbank rate** significantly deviates from the **central bank rate**.	401	2006M7–2015M1
Morocco (MAR)	The **interbank rate** deviates from the **central bank rate**.	47	2002M1–2015M1
Malaysia (MYS)	The **interbank rate** managed closed to the **overnight policy rate**.	20	2004M4–2014M1
Nigeria (NGA)	The **interbank rate** deviates from the **central bank rate** substantially.	323	2006M12–2014M10
Rwanda (RWA)	The **repo rate** and the **interbank rate** differ.	164	2008M1–2014M10
South Africa (ZAF)	The **repo rate** is the central bank rate and it is closely followed by the **interbank rate**.	104	1997M1–2014M5
Sweden (SWE)	The **repo rate** is the central bank rate and is closely followed by the **interbank rate**.	12	1998M6–2015M1
Turkey (TUR)	The **interbank rate** stays close to the overnight deposit rate and is disconnected from the **repo rate**.	213	2010M5–2014M11
Tanzania (TZA)	No official central bank rate. The **overnight interbank rate** frequently out of sync with the **repo rate**.	385	2002M4–2014M9
Uganda (UGA)	The **central bank rate** used since July 2011. Liquidity operations are conducted to the **7D interbank rate** close to the central bank rate.	161	2011M7–2014M12

Source: Central banks web pages and reports and authors' computations.

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